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Technical Notes

On Several Good Methods for Computing the Distortion Factor Relevant to a Foil Placed in an Exponentially Varying Flux

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ABSTRACT

The method of elementary solutions, the C_N method, and the integral transform method are used to compute the flux-distortion factor for a foil placed in an exponentially varying flux.

I. INTRODUCTION

In two recent papers,[1,2] the earlier work of Williams[3] on flux-depression factors due to a constant source was extended to allow the foil to scatter as well as absorb neutrons. Here we wish to give the results for a similar extension when we consider a foil placed in an exponentially varying flux.[4]

We consider the foil to be region 1, $x \in (-a,a)$, and that in the foil and region 2, $|x| > a$, the neutron angular flux is defined by the one-speed neutron transport equation,

$$\mu \frac{\partial}{\partial x} F_\alpha(x,\mu) + F_\alpha(x,\mu) = \frac{1}{2} c_\alpha \int_{-1}^{1} F_\alpha(x,\mu')d\mu' \quad , \qquad \alpha = 1 \text{ and } 2 \quad . \tag{1}$$

Here we seek, for $c_1 < 1$ and $c_2 < 1$, solutions of Eq. (1) such that

$$F_1(\pm a,\mu) = F_2(\pm a,\mu) \quad , \quad \mu \in (-1,1) \quad , \tag{2a}$$

$$\int_{-1}^{1} F_2(x,\mu)d\mu \rightarrow \exp(x/\eta_0) \quad , \text{ as } x \rightarrow \infty \quad , \tag{2b}$$

and

$$\int_{-1}^{1} F_2(-x,\mu)d\mu \rightarrow 0, \text{ as } x \rightarrow \infty \quad , \tag{2c}$$

where η_0 is the discrete eigenvalue for region 2. Explicitly, we wish to compute the flux-distortion factor,

$$\Delta = \frac{\frac{1}{2a}\int_{-a}^{a}\int_{-1}^{1} F_1(x,\mu)d\mu dx}{\frac{1}{2a}\int_{-a}^{a} \exp(x/\eta_0)dx} \quad . \tag{3}$$

From Eq. (3), it is clear that Δ is normalized so that $\Delta = 1$ when $c_1 = c_2$, i.e., when there is no foil. Before discussing the solution, we find it convenient to symmetrize the problem by introducing

$$\psi_\alpha(x,\mu) = F_\alpha(x,\mu) + F_\alpha(-x,-\mu) \quad , \quad \alpha = 1 \text{ and } 2 \quad . \tag{4}$$

Thus, we seek solutions of

$$\mu \frac{\partial}{\partial x} \psi_\alpha(x,\mu) + \psi_\alpha(x,\mu) = \frac{1}{2} c_\alpha \int_{-1}^{1} \psi_\alpha(x,\mu')d\mu' \quad , \tag{5}$$

such that

$$\psi_\alpha(x,\mu) = \psi_\alpha(-x,-\mu) \quad , \tag{6a}$$

$$\psi_1(a,\mu) = \psi_2(a,\mu) \quad , \quad \mu \in (-1,1) \quad , \tag{6b}$$

and

$$\int_{-1}^{1} \psi_2(x,\mu)d\mu \rightarrow \exp(x/\eta_0) \quad , \text{ as } x \rightarrow \infty \quad . \tag{6c}$$

We note that

$$\Delta = (4\eta_0 \sinh a/\eta_0)^{-1} \int_{-a}^{a}\int_{-1}^{1} \psi_1(x,\mu')d\mu' dx \quad . \tag{7}$$

In the following section, we sketch briefly the solution by three different methods, and in Sec. III we list our numerical results.

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